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Architectural Education for a Post-Fossil Future

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Abstract. The transformation to a post-fossil future will require us to radically rethink the way that we live, build, consume and educate. Currently in Europe the construction sector is responsible for nearly 40% of direct and indirect CO_2 emissions [1] and 30% of waste [2] generated. With these numbers only increasing, young designers will carry a huge responsibility for reducing the sector's impact on the environment. Yet in many cases architectural education continues to place form-making in the centre of the curriculum at the expense of an understanding of the complexities of planning in a post-fossil future.

Since its inception in 2017, the Natural Building Lab (NBL) at the Technische Universität Berlin has been exploring new methods of architectural education with the premise that new models and formats are needed in order to equip young designers with the tools they will need to affect change in a rapidly changing, globalised society. The projects undertaken by the Lab up till now have put an emphasis on self-determined learning as the vehicle to involve students proactively in urban-change processes. The first built projects from the Lab, while in diverse contexts, all combine circular, LowTech construction principles with the performance of natural building materials to produce a vision for a post-fossil architecture, often designed and realised by students in trans-disciplinary collaborations. The paper will look at the challenges facing architectural educators and how the Natural Building Lab is aiming to frame its pedagogic strategy based on the realities of resource scarcity and climate change.

Figure 1. NBL Collaborative Design Workshop, TU Berlin fall 2017

1. Introduction – The Big Picture

The current "perfect storm" of social, political, economic and ecological conditions internationally shows little evidence of abating despite the increasingly dire warnings of leading experts. In 2015 the Stockholm Institute for Climate Resilience published an update on their 2009 research on Planetary Boundaries, of the nine boundaries they identified three are already beyond the "zone of certainty", three more are already close to their limit and two cannot yet be scientifically quantified. [3] Sadly, the indications that pursuing a policy of growth of any cost would eventually lead to us to calamity were already identified in 1972 by the Club of Rome. Meanwhile international policy such as the UN's Sustainable Development goals, the Paris Climate Agreement or any number of high profile climate legislation seem unable to make any real empirical progress with political institutions increasingly paralysed by the rise of a new politics of populism fueled by an increasing disenfranchisement with the political establishment across the political spectrum. Encouragement can be had from the increasing mobilisation of a new generation of climate advocates such as Greta Thunberg or the gains made by green parties in the 2019 European Parliament elections in the wake of the Extinction Rebellion protests. Nevertheless, the outlook remains bleak and it is now certain that within a generation the realities of climate change and resource scarcity will require us to completely rethink the way that we live, work, consume and interact with each other and our environment at all scales.

Despite on-going sustainability efforts and increasingly earners public discourse and activism, the building sector remains responsible for around 40% of the European energy consumption[1] and 50% of the overall use of material resources. In addition, around 60% of the waste in Europe (approx. 750 Mio. Tons) is classified as construction and demolition waste (CDW)[2] generated by the building sector. The challenges facing the building sector to meet the targets set out in the Paris climate agreement are enormous and span scales and the traditional disciplinary boundaries.

2. The Post-Fossil Architect

In order to face the challenges facing the profession in times of upheaval, there is a huge potential for architects to use their specific skill set to co-produce new knowledge that can help society combat the challenges posed to the built environment by climate change. However, this will require us to reconsider the position of the architect in a wider societal context. Architects occupy a difficult position in the climate debate, because on a basic level, an architect is someone who designs and constructs buildings – traditionally ever more, bigger and more resource intensive buildings. This is why clients appoint architects, and it is without a doubt seen as our key competency and it is the service for which we usually receive financial remuneration. Furthermore, designing buildings receives the most focus in our education and it is the skill with which we generally most identify ourselves – nearly all of our institutions, associations and presumptions are built on this premise.

For the next generation of young designers scarcity will be the theme that dominates discourse in the profession for the near future. The way that the dynamics of material scarcity will affect all aspects of our lives is only just beginning to be researched. Yet the way that we define and understand scarcity as a concept has potential to open new fields of agency for design practice. Working within the limits of externally defined boundaries has always belonged to the creative process of architecture and design – typically the architect is forced to work within the limits of the site or budget provided by the client in order to be able to realise their masterpiece. However, when we consider design practice as more than just the creation of a series of more or less beautiful of objects, and more as an intervention in an increasingly complex series of processes that react to existing systems and contexts, then working with scarcity is already an unavoidable part of our remit.

Over the last decade neoliberal economists and politicians have used scarcity as the legitimisation for a number of highly damaging austerity measures, cutting social support, infrastructure and services in the name of limited resources. Jeremy Till formulates the central presumption at the heart of this idea of scarcity as a false belief that, "human needs are unlimited, but the means to achieve them are scarce" [4]. In their essay "Design of Scarcity", Goodbun et al. challenge this idea and argue for a new understanding of scarcity as a dynamic socio-material condition, one arising from the uneven

distribution of power and resources and one which can be designed and influenced, rather than an inevitable endgame for the global consumer economy [5]. This understanding of scarcity has serious implications for design practice and provides the framework to imagine a new and expanded field of agency for designers more able to affect change in a rapidly changing globalized society where the challenges posed by climate change span institutional and disciplinary boundaries.

3. The University

Yet despite these challenges architectural education at most international universities is still largely based on the model of the École des Beaux Artes from the early 19th century **Error! Reference source not found.**. The daily image at the nearly 60 architecture schools in Germany for example is characterized by work and presentation formats that put students in competition with each other and design studios set up as a masters studio with a teaching person who sets the content and task. A lack of reference to 'reality' - the architectural practice and the challenges of the non-academic world - is often formulated as a critique to this system. According to the UNESCO/UIA Charter, the only paper on architectural education that is globally agreed on, 'greater diversity is needed […] in architectural education and training'.

In times of scarcity of resources, where the effects of climate change are threatening the lives of many people and leading to global migration and conflict, architects are also calling for a radical shift in thinking. An important approach is the training of young architects, who have the ability to reflect critically, to independently develop new solutions and thus to be aware of their responsibilities as planers. In order to make global urbanization and construction processes socially, ecologically and economically sustainable and thus future-oriented, architecture practice and education must use a cooperative working method across the borders of disciplines and social classes.

4. Learning Approach

The Natural Building Lab (NBL), which was founded at the end of 2017 at the Institute of Architecture of the Technische Universität Berlin, is seeking a methodology to address imbalance by enabling students to learn in a self-determined and collective process. Many of the cornerstones of the concept deliberately challenge existing notions of authorship and authority established within the university and professional context. This section will outline some of the key aspects of the Lab's learning approach and how they relate to the idea of a post-fossil architect outlined above.

4.1. DesignBuild Methodology

The DesignBuild methodology dates back to the Community Design Movement in the US in the 1960s, whereas similar approaches can be witnessed before that time in schools like the Bauhaus, Talisien West or the Black Mountain College. Today there are more and more architecture schools worldwide undertaking projects where students are physically involved in the realisation of their designs in collaboration with local communities and NGOs. Networks like the DesignBuild XChange Network [7] and the Design for the Common Good network [8] are showing the power and the relevance of this global movement.

The first DesignBuild Studios in Europe, apart from the endeavors of the 1920s and undertaking regular, yearly project cycles were established in the late 1990s – the Mexikoprojekt (Prof. Ingrid Götz, TU Berlin), the DesignBuild Studio at TU Wien (Peter Fattinger) or the Live Projects at Sheffield School of Architecture. For 20 years a huge number of projects was realised by different chairs at TU Berlin. The EU funded research project "European DesignBuild Knowledge Network" (EDBKN) [9] initiated by Ursula Hartig, Simon Colwill and Nina Pawlicki at Habitat Unit (TU Berlin) as part of an international consortium developed criteria for DesignBuild projects and has set up the international network dbXchange.eu.

Definition of DesignBuild and its methodology by EDBKN: DesignBuild Projects are components of higher education in the field of built environment that allow students to be physically involved in the materialisation of their designs. DesignBuild Projects must: be based in higher education; have a brief,

budget and timeframe; be built; have students involved in the design AND construction of the project; be of architectural, social, cultural, scientific, technical or artistic relevance. The Natural Building Lab is carrying on the DesignBuild tradition at TU Berlin.

4.2. Trans-disciplinary Collaboration

The image of the architect established by the modernists was of one expert who could control the building process from the start to finish. The complexity of the contemporary building process requires skills and knowledge that go well beyond the expertise of one discipline. This has resulted in a fractured field where experts from different disciplines struggle to integrate their different areas of knowledge into a linear, phase-based design process, which is often not conducive to collaboration. By integrating input from other disciplines at an early stage of the design process and fostering a truly collaborative instead of competitive spirit, it would be possible to eliminate many of the process-based difficulties that arise and thus improve the efficiency of the project process by recognizing synergies, opportunities and problems at an earlier stage. Yet while inter-disciplinary working remains a popular buzz word in the industry, in reality restructuring processes to truly enable trans-disciplinary collaboration is a huge challenge and requires a bottom-up rethink. It is of huge importance that the different disciplines become used to working collaboratively during the early stages of their studies.

4.3. Co-production and Co-ownership

We see a changing role for designers in a societal context, one of the architect as a moderator and facilitator. There is a huge potential for architects to use their unique skill set to integrate skills, knowledge and input from project actors into complex design processes by working on an equal level. Only through an integrated and participative methodology can true shared ownership of outcomes be achieved. By placing a high value on this input from actors outside of the profession, it is possible to co-produce knowledge and foster a shared authorship. Thus architecture becomes a tool and vehicle to instigate bottom-up change in society, as opposed to being limited to an artistic service only available to the few.

Figure 2. Building Cycle, structural test, January 2018

Figure 3. Community Collaboration, Building Cycle December 2017, CRCLR hall, Berlin Neukölln

4.4. Self-determined learning

Heutagogy is an emerging field of research into the effectiveness and practice of self-determined learning processes [11]. With the proliferation of digital media the way in which we access and consume knowledge has changed beyond recognition and pedagogic methods and institutions are struggling to catch up. Traditionally universities place a high value on the one-way transfer of knowledge from teachers to students and this is the premise upon which accepted teaching formats and institutions are built. Yet when we move from the perspective of "knowledge hoarding" to one of "knowledge sharing", we begin to unlock the true potential of a two-way learning process for both the "teacher" and the "student" (Fig 2 and Fig 3). Furthermore with the ease in which digital media allow us to access new knowledge, there is a potential for institutions to place a renewed focus on skills (how to apply knowledge) and most importantly values (why to apply knowledge).

5. Teaching, Research & Practice

The main activities of the Natural Building Lab can be roughly grouped into three disciplines – learning, research and practice, with synergies and overlaps existing between them. For instance, a DesignBuild studio project can easily incorporate aspects of all three themes as will be discussed later in this paper. The emphasis is on blurring the boundaries between these often-separated aspects of architectural practice at an institution by focussing the sharing of knowledge between projects. This section will briefly outline the way that the approach is applied in these three fields.

5.1. Learning (The Studio)

The central part of the Lab's learning approach is the design studio, in which 15 to 35 students in the Bachelor or Master program collaboratively produce solutions to a changing set of themes. One of the challenges of the studio format is an established culture of competition among students, one born out of the competitive nature of design practice – the design competition being the traditional battleground in which architects pitch their ideas against each-other to win a contract. Yet the anonymous design competition reduces the scope of an architect's services to an artistic/technical service, especially because the competition always starts with a fixed and non-negotiable brief. Basing the studio format solely on the reference of a design competition hugely limits the creative potential of the process and only serves to further entrench a culture of "knowledge hoarding".

As a critique to this culture NBL studios place an emphasis on collaboration by encouraging participants to work in larger groups of 4 and upwards, sometimes even the whole studio will work together on one project. This forces students to confront themselves with the challenges of working in large and diverse groups, whether by finding ways to reach a consensus among a group of individuals from varying cultural backgrounds or by learning how to best utilise the varying skills and interests of group members, they are able to develop skills essential for a collaborative and open-minded design practice.

The studio also fosters collaboration by challenging the accepted formats of presentation and tutorials, where an emphasis is usually on the students being given direction by a panel of experts within a highly charged and hierarchical atmosphere. This format retains then principle that the instructor somehow is possessed of the answer, and to obtain it the student must follow the rules [12]. NBL's key format is a weekly stand-up discussion set up as a circle, this challenges the established hierarchy between teacher and student. Prior to the discussion of a project another group is identified as responsible for feedback and this group will start the discussion. Members of the chair will join the discussion but not pass judgement on a given project, the emphasis is on a collaborative learning process for student and teacher alike. This method, working on an eye level within the whole team promotes the self-discovery of the students and enables them to contribute each with their own qualities to the process. Another challenging culture is the value of students work, typically students work for the whole semester on a design studio, which after a presentation is added to the portfolio and then forgotten. Furthermore, students are not deemed as capable or responsible enough to work with real clients or materials – first one has to learn the technical skills before being able to apply them in practice. The DesignBuid methodology clearly challenges this tenant and the application of this in practice will be discussed in a further section. Yet the benefits and potential of giving students the opportunity to apply their ideas in a real context greatly changes how they consider the ownership of their ideas.

An NBL studio will always aim to provide students with the chance to work with real contexts, actors and materials during the design process. By providing this context for their work, participants gain valuable experiences that are for their future practice. (Fig 4.)
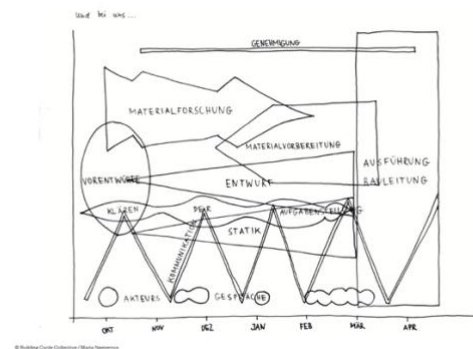
5.2. Research (The Lab)

The subject of what constitutes research within the field of architecture is one that has always been discussed controversially. Especially the question of whether design in and of itself can be considered as a form of research is one that is especially bitterly contested by thinkers on both sides of the divide. The Natural Building Lab aims to place research within the context of shared knowledge production integrating it into the other disciplines of research and practice. With an established expertise in the field of natural building materials and a strong link to a number of projects completed by the office ZRS Architekten Ingenieure, the NBL is able to provide a bridge between new and experimental concepts and its applications for users on the ground.

Design studios can be conceived on the basis of findings from a research project, as with the award-winning project Infozentrale auf dem Vollgut which will be discussed in more detail in the following section. In that case providing students with access to ideas and concepts about the use of recovered timber as a resource for new construction, which eventually led to the realization of a pavilion, allowed the research project to showcase its findings in a larger scale and more prominent case study project than would have been otherwise possible. Furthermore, the experimental nature of the project provided further findings and knowledge, which could be reintegrated and furthered by the research team. Again, in this instance the idea of individual authorship is challenged by the production of new knowledge in a collaborative integrated process.
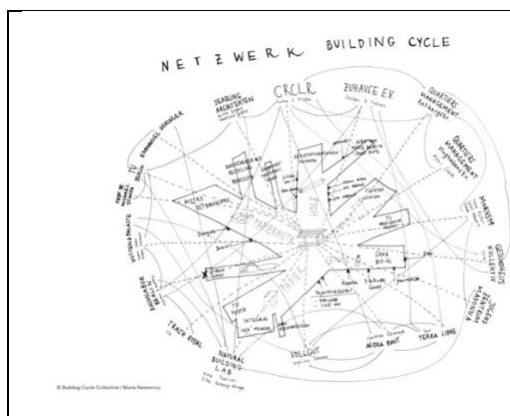
Fig 4. Building Cycle network, partner connection and material resourcing	**Fig 5.** Building Cycle, workflow, design and construction

5.3. Practice (The City)

The NBL emphasizes a *critical* architecture practice based on a critical understanding of external conditions, in this case external to the context of an architecture school. This practice can take the form of hands-on construction and experimentation in 1:1 or an application and testing of ideas developed in the studio to a real context.

Often design projects will be initiated with the set aim of designing and realizing a building task. Architectural design often takes place on paper, or increasingly on a screen, and while it is possible to teach the theory of construction, there is no substitute for hands on experience. The realities of a DesignBuild project also show the inadequacy of seeing a building project as a linear process in which a series of phases are completed one after another (Fig. 5.). This mindset limits the ability of different disciplines to locate synergies at different stages of the project by always focusing on one complete package of work at each stage of the process, an aim which understandably becomes the focus of each party's attention.

The opportunity to experiment in 1:1 with real materials gives students the chance to apply their knowledge responsibly in a creative context. The Lab is also equipped with a 300sqm research and workshop space where 1:1 prototypes, pre-fabrication processes and research on earthen materials can take place all year round. Furthermore, the NBL Hub, one of the results of the first master studio in

2017/18, is a 70 sqm reversible arch structure based on the idea by Leonardo Da Vinci designed to be transported by cargo bike and assembled by 2 people within 10 minutes. The Hub provides a mobile outpost or workshop space and can be used to provide a space for events and encounter in the neighborhoods where projects are based (Fig 6 – 8).

Figure 6. NBL Hub transported by cargo bike

Figure 7. NBL Hub, assembly

Figure 8. NBL Hub, mobile outpost

6. From Building Cycle to "Infozentrale" – the first NBL project

The "Infozentrale auf dem Vollgut" was designed and realised by a group of 36 students as part of the BUILDinG CYCLE design studio from the Natural Building Lab at the Technische Universität Berlin in Winter Semester 2017. In co-operation with the research project RE4, a building embodying circular construction principles was realised from waste materials as a DesignBuild project, offering an answer to questions relating to resource-positive construction in an urban context and embodies a new method of architectural production for a post-consumer society. In the opening weeks of the project the student groups undertook a material research, where innovative low-tech constructive elements were created using a wide range of waste materials Through this research the groups established a network, through which they were able to source larger amounts of the waste materials used for the building – recovered timber and cardboard. The load bearing structure of the building is formed from timber recovered from local demolition sites and a dismantled architectural installation from the International Garden Festival 2017, thus providing a second usage cycle for this valuable resource. The 8m x 10m roof structure is formed by a pre-stressed grid of layered and interlocking re-used timber beams with reversible connections designed for disassembly. For the wall elements an experimental system was developed utilising stacked upcycled cardboard fruit boxes filled with shredded paper as insulation and covered with recovered large format posters and plot drawings – common waste materials within the architecture faculty. The project embodies circular construction principles and serves as a prototype for a LowTech post-fossil architecture based on the realities of resource scarcity and climate change (Fig 9 and Fig 10).

Figure 9. Infozentrale, installation roof construction, timber beam lattice grid

Figure 10. Infozentrale, raw construction, timber beam grillage, fixed columns

During the design and construction phase, the students networked with around 200 participants on and around the site in order to get a deep understanding of the situation and to anchor the project locally and to resource materials for building (Fig. 4). The project set new standards for the Natural Building Lab's work and achieved feats above and beyond the aims set at the project's outset. The entire pavilion utilised connections and materials that could be easily executed using hand tools and with the minimum of previous experience, as such the building sets a standard for a LowTech building system that can be adapted and reformed by the end user. Thus the project sets itself up as an alternative to the standard and highly commercialised standard methods of architecture production typical of the fossil-economy. Furthermore the project succeeded in establishing a number of new material networks and cycles within the neighbourhood, connections which have been documented and can be further built upon in further projects. As a DesignBuild project the studio succeeded in integrating a wide range of inter-disciplinary collaborations both within the university and with actors on the Vollgut Areal and from the surrounding neighbourhood. The finished Infozentrale (Fig 11 and Fig 12) serves as an embodiment of these principles and as a built prototype for a post-fossil architecture based on the realities of resource scarcity and climate change. The Infozentrale has since been awarded as a runner-up in the Deutsche Holzbau Preis 2019 and with a special prize in the Holzbau+ Competition 2019.

Figure 11. Infozentrale, south-west elevation	**Figure 12.** Infozentrale, indoor space.

7. Taller Tropical, Moravia, Medellin

The Taller Tropical Moravia is the latest in a series of interventions which seek to promote environmental education in the Moravia neighborhood of Medellin, through the collective construction of a community space for meeting and learning. The project was conceived by the Moravian community leaders and international students, within the framework of Urban Lab Medellín | Berlin, a cultural and academic exchange between the two cities that began in 2016 with the goal of developing local solutions for global challenges.

Starting with the premise that the integral and sustainable development of cities can only be built collectively, the platform linked inhabitants, civic movements, NGOs, artists, students and professionals from different disciplines, and actors from the private and public sectors; to discuss, research, design and build together. During summer schools in Medellin and Berlin, workshops, events, conferences and interventions were held in the public space, such as the renovation of the Tropical Oasis Stairs in Moravia.

Throughout this process, scenarios and strategies were developed to transform Moravia into a sustainable model neighborhood. At the Berlin Summer School in July 2017, 9 Moravian leaders raised the idea of converting El Morro areas into a laboratory for environmental and food education. This proposal called "Sowing Life" (Sembrando Vida) was elaborated with students of several universities and the inhabitants of Moravia. Due to a certain slowness of reaction from the public administration, the

project could not be executed this year. However, the process has raised awareness on the issues that the project sought to address, a wide network of allies and a wealth of knowledge. The community continued asking that the project be carried out and promoted the development of a Plan B: the Taller Tropical Moravia in September 2018. The project is a collaboration with and based on previous projects at Habitat Unit, TU Berlin (Fig 13 – 15).

The Taller Tropical was designed and realised by an inter-disciplinary design studio at the Natural Building Lab with architects and civil engineers. During the realisation phase participants collaborated directly with local tradesmen, a Columbian bamboo construction collective, local school children and members of the local community. The project is the embodiment of shared ownership, authorship and production and an example of how a small intervention can instigate larger change processes in an international context.

| Figure 13. Taller Tropical Detail, platform | Figure 14. Taller Tropical, two-story bamboo structure located on the first floor | Figure 15. Taller Tropical Detail, frame corner |

8. Conclusion & Outlook

After nearly four semesters of activity, a broad network of projects and partners has developed around the Natural Building Lab, and this continues to grow with each new project. We understand the Lab as a network through which diverse actors can co-operate in activities aiming to induce long-term societal change for the betterment of the planet and those who inhabit it. With the first class of NBL "graduates" departing the university this Autumn, we are excited to see how this network will develop and how the values and skills learned during student's studies can be applied to the wider working context of post-university graduate jobs. Certainly, every semester has seen a core group of studio participants forming a "collective" to further pursue the themes and collaborations introduced during the semester in the longer term. This is a very encouraging dynamic and shows that giving students the opportunity to work with real people, places and materials allows them to develop the confidence to pursue their ideas independently and to position their ideas with the context of wider societal and architectural discourse. Furthermore, it allows students to form their own ideas about the role of an architect in a societal context based on these experiences.

The Lab's network is also growing to encompass a number academic and industry-based collaborators for research projects spanning from the circular potential of earthen building materials to questions surrounding what we can learn about a climate adaptive and resource efficient architecture from pre-fossil cultures. The findings from these projects set the basis for further integration of teaching, research and practice activities.

In conclusion the challenges facing young architects in times of scarcity are huge and will require them to question the established norms and preconceptions existing in architectural practice at large.

Only by placing an enhanced emphasis on the collective over the individual and collaboration over competition will the sector by able to successfully navigate the dramatic changes that will be required to remain relevant in the face of climate change and resource scarcity. The Natural Building Lab is seeking to equip young designers with the knowledge, skills and values they will need to define a new role and potential for architects in a post-fossil society (Fig 15).
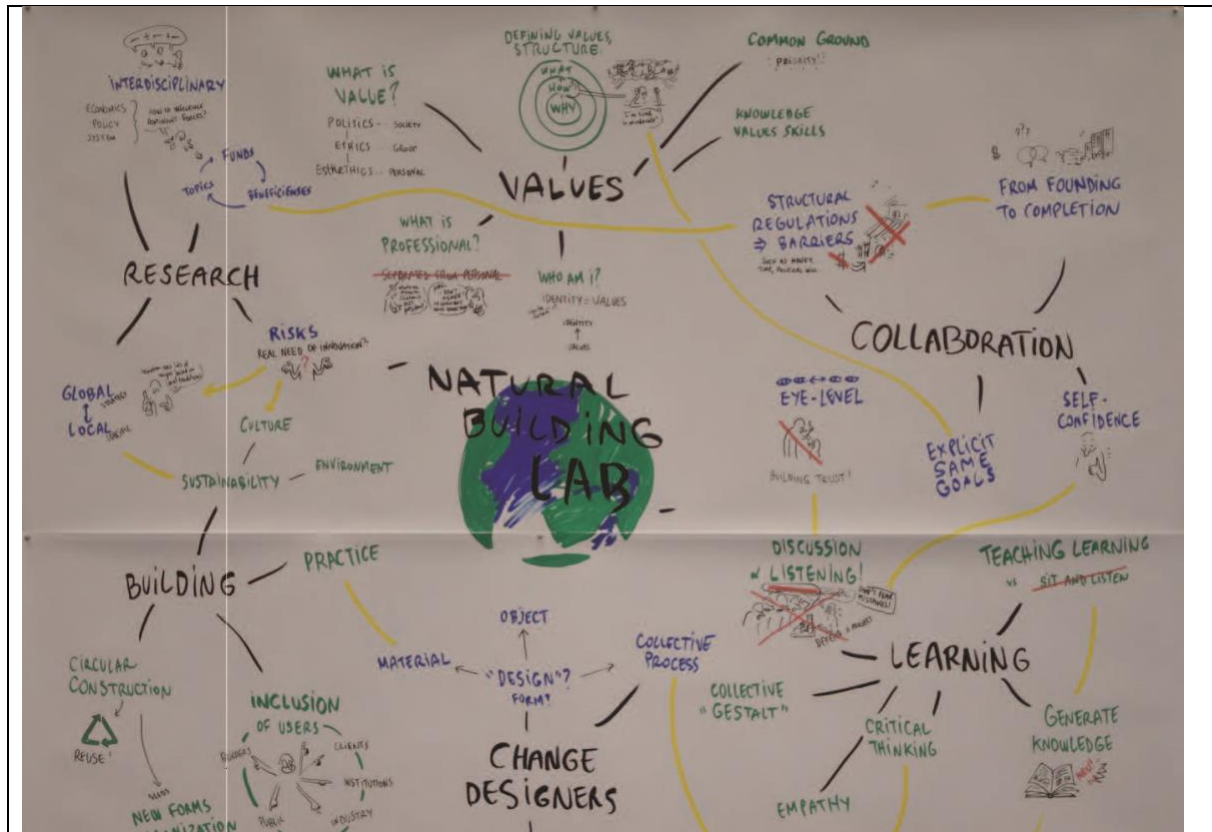
Fig 16. Natural Building Lab, Launch April 2018, NBL Documentation of discussion about the direction of the department with 50 members of international network.

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